Invasive alien fern-taxa in north-western Germany

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Within the last 20 years, the fern flora of northwest Germany has undergone striking changes. Compared with flowering plants, neophytic fern species are rarely found in Germany. In addition to an area expansion of some indigenous species like *Asplenium adiantum-nigrum*, *Asplenium scolopendrium*, *Dryopteris affinis* s. l. and *Polystichum aculeatum* (s. KEIL et al. 2009) – originally found only in the low mountain range, now spread far into the northern German lowlands – more and more findings of neophytic fern species were simultaneously observed. Those are species that had not been known from the lowland area or that had been known only from a few locations, for example *Azolla filiculoides* (DÜLL & KUTZELNIGG 1987) and *Onoclea sensibilis* (FUCHS & KEIL 2004). Starting a few years ago in the Ruhr area and in Rhineland, findings of sub-tropical fern species were observed in cellar light shafts and in wells, as well as on walls, species that until then had only been grown as greenhouse plants, for example *Adiantum capillus-veneris*, *Adiantum raddianum* and *Pteris cretica* var. *albo-lineata*. The newest examples of additional neophyte fern species are *Pteris multifida*, *Pteris cretica* s. str., *Cyrtomium fortunei* var. *clivicola* and *Selaginella kraussiana* (SARAZIN et al. in press., compare Tab.1).

Pteris cretica* var. *albo-lineata (*Pteridaceae*) in a cellar light shaft of the Oberhausen Library (Northrhine-Westphalia, Germany). First record in Germany 2007.

Pteris multifida (*Pteridaceae*) in a cellar light shaft in Herne (Northrhine-Westphalia, Germany). Second record in Germany 2009.

Adiantum raddianum (*Adiantaceae*) in a cellar light shaft of the Oberhausen Library (Northrhine-Westphalia, Germany). First record in Germany 2005 in Essen

Adiantum capilis-veneris (*Adiantaceae*) on a wall in Botanical Garden Bonn (Northrhine-Westphalia, Germany). First record 2008.

Cyrtomium falcatum* ssp. *clivicola (*Dryopteridaceae*) in a cellar light shaft in Düsseldorf (Northrhine-Westphalia, Germany). First record 2009.

Onoclea sensibilis (*Athyriaceae*) in a riparian floodplain in Duisburg (Northrhine-Westphalia, Germany). First record in West-Germany 2002.

Selaginella kraussiana (*Selaginellaceae*) in a park (Gruga) in Essen (Northrhine-Westphalia, Germany). First record in Germany 2008.

Azolla filiculoides (*Azollaceae*) in a pont in Mülheim an der Ruhr (Northrhine-Westphalia, Germany).

While in the Atlantic-influenced climatic region of Europe, where these fern species have been found for many years (e. g. EDGINGTON 2008, VERLOOVE et al. 2007), in Germany most of them were only detected in the last 5 years.

Tab. 1: Invasive alien fern-taxa in Germany and there habitats (x = occurrence)

Taxon	light-shaft (cellar)	wall	soil	water well	Gully	riparian	pond
Adiantum raddianum	x			x			
Adiantum capillus-veneris		x					
Cyrtomium fortunei var. *clivicola*	x		x		x		
Pteris cretica s. str.		x					
Pteris cretica var. *albo-lineata*	x						
Pteris multifida	x	x					
Selaginella kraussiana			x				
Onoclea sensibilis			x			x	
Azolla filiculoides							x

In most cases, populations persist also during following years as far as mechanical cleaning is not performed. Despite harsh frost with temperatures as low as -14,6° C during the last winters (2008/2009, 2009/2010) even in the city of Mülheim an der Ruhr (where a meteorological station is located), it is noteworthy that the plants outlasted unspoiled. At three locations where the ferns grow (two light shafts for cellars and one well shaft) metering devices which log temperature and relative humidity every 20 minutes were installed in order to investigate the climate conditions.

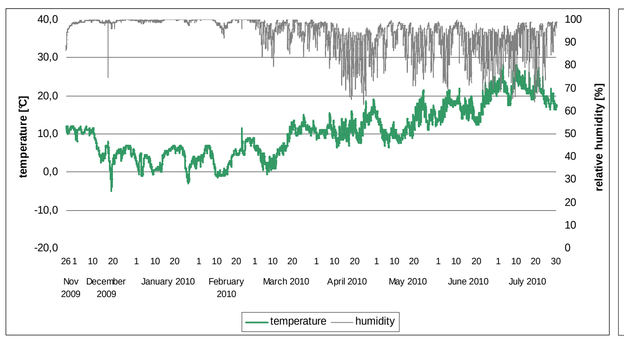

Fig. 1: Records of the data-logger in the light shaft for cellars in Oberhausen Library

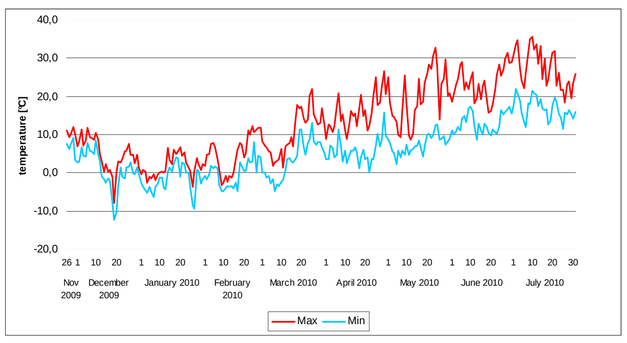

Fig. 2: Records of the meteorological station in Mülheim an der Ruhr

As the records of the data loggers show, the growing sites are well sheltered (see fig. 1). Thus, only a few days during the winter reach minimum temperatures of -5°C and relative humidity is damp ed, too (compare fig. 2).

The observed individuals originated from plants which are traded as houseplants or for fish tanks, except for *Onoclea sensibilis* which is also offered for gardening outdoors.

It terms out that even subtropical fern-species are able to establish in climatically favoured urban areas within central Europe.

Although strong spreading is unlikely the results of the study give reason to assume that the observed species are not sufficiently mapped in central Europe. A comprehensive study of such special locations would probably bring up further records also outside the investigated area.

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